

05/21/98
U.S. PTO

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

A

Docket No. 97-125

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Transmitted herewith for filing is the patent application of Inventor(s):

Richard L. Solomon

For: **METHOD AND APPARATUS FOR EMULATING A DEVICE WITHIN A DATA PROCESSING SYSTEM**

Enclosed are also:

6 Sheet(s) of Drawings
 An assignment of the invention to Symbios, Inc.

CLAIMS AS FILED

FOR	Number Filed	Number Extra	Rate	Basic Fee (\$790)
Total Claims	40	-20 =	20 X \$ 22	= \$ 440
Independent Claims	6	-3 =	3 X \$ 82	= \$ 246
Multiple Dependent Claims	0		X \$270	= \$ 0
Total Filing Fee				= \$ 1476

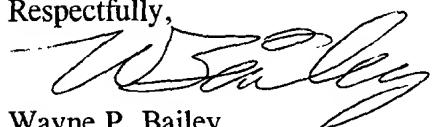
Please charge the above filing and recording fees to the account of Symbios, Inc., Deposit Account No. 19-5405.

Please have all communications concerning this application and the recorded Assignment directed to:

Wayne P. Bailey
Symbios, Inc., Law Department
2001 Danfield Court
Fort Collins, CO 80525

Our telephone number is: (970) 225-4908.

Respectfully,



Wayne P. Bailey
Attorney for: Richard L. Solomon

APPLICATION FOR
UNITED STATES LETTERS PATENT

FOR
METHOD AND APPARATUS FOR EMULATING A DEVICE WITHIN A DATA
PROCESSING SYSTEM

By:

Richard Solomon

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RACHELLE L. BONNIER

Typed or printed name of person mailing correspondence

BACKGROUND OF THE INVENTION

1. Technical Field:

An improved data processing system and in particular to a method and apparatus for
5 emulating a device within a data processing system. Still more particularly, the present invention
relates to an improved method and apparatus for emulating a device that has been disconnected
from the data-processing system.

2. Description of the Related Art:

10 A good server data processing system is dependent on an efficient input/output (I/O) system. After all functional requirements have been defined and all the components specified, a server relies heavily on its storage I/O subsystem. This critical subsystem controls the movement of data between the CPU and peripheral devices. No matter how fast the CPU, a single I/O bottleneck can keep any server from living up to its full performance potential. Therefore, an
15 important aspect of building a better server is building an efficient storage subsystem. Today's servers place an extra demand on storage systems. Faster CPUs require more and more data from the storage system to meet increased data accesses. Multitasking operating systems allow data to for multiple threads. Multimedia applications also heavily tax a server's data transfer ability with huge files. Faced with these facts, a server can no longer perform to its optimum unless built with
20 an efficient I/O system. The American National Standards Institute (ANSI) has a standard for defining a standard high-speed parallel interface that is used to provide for the needed speed in I/O transfers. The standard is referred to as the Small Computer System Interface (SCSI) standard. A SCSI interface is used to connect microcomputers to SCSI peripheral devices, such

as many hard disks and printers, and to other computers and local area networks. SCSI provides for a local I/O bus that can be operated over a wide range of data rates. The primary objective of the SCSI interface is to provide host data processing systems, such as servers, with device independence within the class of devices. Thus, different disk drives, tape drives, printers,
5 optical media drives, and other devices can be added to a computer without requiring modifications to system hardware or software.

The interface protocol includes provision for connection of multiple initiators (SCSI devices capable of initiating an operation) and multiple targets (SCSI devices capable of responding to a request to perform an operation). Distributed arbitration is built into the architecture of SCSI. A priority system awards interface control to the highest priority SCSI device that is contending for use of the bus.
10

A number of operating systems, such as Unix and OS/2, require that SCSI devices be attached to the data processing system and powered up at boot time. This situation is not generally a problem for permanently attached peripherals, such as disk drives. For devices, such as tape drives or CD-ROM drives, which might be shared among several data processing systems, connecting a device often requires a reboot. Such a situation is disruptive to users of a data processing system and increases the time associated with a device swap. Therefore, it would be advantageous to have a method and apparatus for reducing the time associated with a device swap and to reduce the disruption to users of a data processing system.
15

SUMMARY OF THE INVENTION

The present invention provides a method and apparatus in a data processing system for mimicing a device attached to a bus. Signaling is detected on the bus indicating a request to

5 access the device. The bus is then monitored for a response by the device. If a selected period of time passes without a response being made by the device, a response suitable to indicate the presence of the device is sent onto the bus.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself however, as well as a preferred mode of use, further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

5 **Figure 1** is a block diagram of a data processing system in which the present invention may be implemented;

10 **Figure 2** is a logic block diagram of a mimic device in accordance with a preferred embodiment of the present invention;

Figure 3 is a functional block diagram of a mimic device in accordance with a preferred embodiment of the present invention;

15 **Figure 4** is a flowchart of a process employed in a bus snoop function in accordance with a preferred embodiment of the present invention;

Figure 5 is a flowchart of a process used in a bus interface and a control function in accordance with a preferred embodiment of the present invention; and

20 **Figure 6** is a flowchart of a process for adding a device for emulation or mimicking in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION

With reference now to the figures, and in particular with reference to **Figure 1**, a block diagram of a data processing system **100** in which the present invention may be implemented is illustrated. Data processing system **100** employs a peripheral component interconnect (PCI) local bus architecture.

5 Although the depicted example employs a PCI bus, other bus architectures such as Micro Channel and ISA may be used. Processor **102** and main memory **104** are connected to PCI local bus **106** through PCI bridge **108**. PCI bridge **108** also may include an integrated memory controller and cache memory for processor **102**. Additional connections to PCI local bus **106** may be made through direct component interconnection or through add-in boards. In the depicted example, local
10 area network (LAN) adapter **110**, SCSI host bus adapter **112**, and expansion bus interface **114** are connected to PCI local bus **106** by direct component connection. In contrast, audio adapter **116**, graphics adapter **118**, and audio/video adapter (A/V) **119** are connected to PCI local bus **106** by add-in boards inserted into expansion slots. Expansion bus interface **114** provides a connection for a keyboard and mouse adapter **120**, modem **122**, and additional memory **124**. SCSI host bus
15 adapter **112** provides a connection devices such as hard disk drive **126**, tape drive **128**, CD-ROM **130**, scanner **132**, removable hard disk **134**, and mimic device **136** through SCSI bus **138** in the depicted example. Those of ordinary skill in the art will appreciate that the hardware in **Figure 1** may vary. For example, other peripheral devices, such as optical disk drives and the like may be used in addition to or in place of the hardware depicted in **Figure 1**. The depicted example is not
20 meant to imply architectural limitations with respect to the present invention.

The present invention provides a method, apparatus, and instructions for emulating a device that has been removed or disconnected from a data processing system. In the depicted example, the functions emulated are those needed to convince the operating system that the device being emulated is present or connected to the data processing system. The depicted example does not
25 provide other functions actually employed to process actual data transfers. Mimic device **136** in depicted example in **Figure 1** is the location of processes for emulating a device. The processes

employed by mimic device 136 may be performed using various mechanisms. For example, the processes may be implemented in a state machine, or as instructions for execution by a processor within mimic device 136. Mimic device 136 is employed to emulate or “mimic” a device that has been removed or disconnected from SCSI bus 138. In the depicted example, when a device is 5 “mimicked” or “emulated”, the responses provided or signals onto the bus are those sufficient to convince the operating system that the device being mimicked or emulated is present in the data processing system. Actual input/output functions are not provided as part of the mimicking or emulation of the device in these examples. Each of the devices connected to SCSI bus 138 is assigned an identification (ID). Eight distinct phases are present in SCSI buses: A bus free phase, 10 an arbitration phase, a selection phase, a reselection phase, a command phase, a data phase, a status phase, and a message phase. During the selection phase an ID will be placed onto SCSI bus 138 identify the device that is to be the target in an operation. The target of an operation is a device that responds to a request to perform an operation. An initiator is a device that initiates an operation. Mimic device 136 in the depicted example, stores an ID for each device that mimic device 136 is to 15 emulate or mimic. If mimic device 136 detects an ID for a device that mimic device 136 is to emulate, it will then wait to see if the device responds within a selected period of time. If the device does not respond within the selected period of time, mimic device 136 returns responses to emulate the device. In particular, mimic device 136 in the depicted example, is employed to convince the operating system that the mimicked device is actually present on SCSI bus 138.

20 This emulation or “mimicking” of a device that is absent is useful in solving the problem in which an operating system requires a SCSI device to be attached to the SCSI bus and powered up at boot time for later use. During boot up, the operating system sends devices an inquiry command, which requests that a SCSI device identified itself and its characteristics. This information is pre-stored within mimic device 136 and returned by mimic device 136 in response to the inquiry 25 command when the device to be emulated or mimicked is absent, not powered up, or disconnected from SCSI bus 138. Other commands such as data transfer requests, results in mimic device 136

returning an error in the depicted example.

During the SCSI selection phase, an initiating device sends out an ID for a target device and waits for up to 250 milliseconds for the target device to assert a busy signal. This busy signal is a signal that indicates the presence of the target device and the target device's ability to proceed with the protocol. Modern SCSI devices typically respond to the selection phase within several milliseconds. If mimic device 136 does not detect assertion of a busy signal for some portion of the 250 millisecond time period, mimic device 136, then senses that the device it is to mimic is absent or not powered up. Once mimic device 136 determines that the device it is to mimic is absent, mimic device 136 will assert a busy signal and continue protocol interactions with the initiator.

Turning next to **Figure 2**, a logic block diagram of a mimic device is depicted in accordance with a preferred embodiment of the present invention. Mimic device 200 includes a SCSI bus interface 202, which provides communication to a SCSI bus. In addition, mimic device 200 also includes microprocessor 204 and associated memory 206. SCSI bus interface 202 provides the interface to the SCSI bus for mimic device 200. Microprocessor 204 processes instructions stored within memory 206. In addition, data, such as IDs for devices to be identified and data to be sent in while emulating a device, are stored within memory 206. These components in **Figure 2** are implemented within a single chip in accordance with a preferred embodiment of the present invention.

With reference now to **Figure 3**, a functional block diagram of a mimic device is depicted in accordance with a preferred embodiment of the present invention. Mimic device 300 includes a control function 302, a bus snoop function 304, and a bus interface function 306. In the depicted example, bus snoop function 304 and bus interface function 306 both are located within SCSI bus interface 202 in **Figure 2**. These two functions may be implemented in circuitry located in SCSI bus interface 202. Control function 302 is implemented within microprocessor 204 and memory 206 in which microprocessor 204 executes instructions stored within memory 206. Although in the depicted example, the control function, the bus snoop function, and the bus interface function are

shown as separate blocks, these functions may be implemented in a single microprocessor core depending upon the implementation.

Turning now to **Figure 4**, a flowchart of a process employed in a bus snoop function is depicted in accordance with a preferred embodiment of the present invention. The process begins 5 by watching the bus for a selection phase to begin (step 400). During the selection phase, an identification, ID, is sent onto the bus in which the ID identifies the device that is selected for an I/O transaction. A determination is made as to whether the ID is for a device that is to be emulated or mimicked (step 402). If the ID is not for a device that is to be emulated, the process returns to step 400 as described above to wait for another selection phase. On the other hand, if the ID is for a 10 device to be emulated, a timer is started (step 404). The timer is used the bus snoop function to determine whether the device to be emulated will respond within a selected period of time. After the timer has been started, the process waits for an occurrence of one of two events: (1) a busy signal that is asserted on the SCSI bus or (2) a time out from the timer (step 406). After an occurrence on one of the two events, a determination is made as to whether the timer timed out 15 (step 408). If the timer has not timed out, the process for the bus snoop function resets the timer (step 410) and returns to step 400 as described above. In this case, a busy signal has been asserted onto the SCSI bus, meaning that the device is present on the bus and is handling the requested operation. If the timer has timed out, the device that is to be emulated or mimicked is either not 20 present, not powered up, or for some other reason is unable to respond within the selected period of time. At this time, a signal is sent to the bus interface by the bus snoop function to accept the transaction for the device (step 412). The bus snoop function waits for the bus interface function to complete (step 414) with the process then returning to step 400. A more detailed explanation of the bus interface function and the control function is described in **Figure 5** below.

Next, with reference to **Figure 5**, a flowchart of a process used in a bus interface and 25 control function is illustrated in accordance with a preferred embodiment of the present invention. Process begins on waiting for the signal from the bus function indicating that the current transaction

should be emulated or mimicked (step 500). Thereafter, the busy signal is driven onto the SCSI bus to accept the transaction (step 502). Next, the bus command is processed per the bus protocol (step 504). This step is intended to indicate in the depicted example that various bus commands will have different formats (e.g. six byte or ten byte command descriptor blocks (CDBs)) and that the 5 mimick device accepts them according to the bus protocol. Then, the various bus commands are analyzed in order that a determination is made as to whether the command is an identity (IDENTITY), inquiry (INQUIRY), or other non-data transfer command (step 506). If the command is an identity, inquiry or other non-data transfer command, the process responds using pre-stored data according to the bus protocol (step 508). Otherwise, the process responds with a not 10 ready signal (NOT_READY) or other deferral response as appropriate per the bus protocol (step 510). Afterwards, the process in either event proceeds to determine whether additional bus commands are present for processing (step 512). If additional commands are present for processing, the process then returns to step 512 to process the bus command. Otherwise, the 15 process signals the snoop bus function to resume operation in step 414 in **Figure 4**. If additional commands are not called for by the bus protocol, the process then ends the transaction per the bus protocol (step 514). Next, the bus snoop function is sent a signal to resume operation (step 516) with the process terminating thereafter.

A mimic device may be externally programmed with the data needed to respond to commands for an emulated device. Alternatively, the mimic device may snoop the SCSI bus for 20 the presence of the device to obtain the needed data.

With reference now to **Figure 6**, a flowchart of a process for adding a device for emulation or mimicking is depicted in accordance with a preferred embodiment of the present invention. The process begins by receiving a command to add a new device (step 600). Thereafter, the ID for the new device is received (step 602), and the ID is stored (step 604). Thereafter, the process monitors 25 for the ID on the SCSI bus each time a selection phase occurs (step 606). When the ID is detected during a selection phase, responses to non-data transfer commands are recorded and stored (step

608). After the data has been recorded, the new device is added as a device that is to be emulated or mimicked (step 610).

Thus, the present invention provides an improved method and apparatus for emulating or mimicking a device within a data processing system. The present invention provides this advantage 5 through monitoring a bus on which the device is normally connected and emulates or mimicks the device in response to detecting an absence of a response from the device after a selected period of time. In the manner, an operating system may be convinced that the device is present, resulting in decreased disruption for uses of a data processing system and decreasing time needed to swap devices.

10 It is important to note that while the present invention has been described in the context of a fully functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present invention are capable of being distributed in a form of a computer readable medium of instructions and a variety of forms and that the present invention applies equally regardless of the particular type of signal bearing media actually used to carry out the distribution. 15 Examples of computer readable media include: recordable-type media such a floppy discs and CD-ROMs and transmission-type media such as digital and analog communications links.

20 The description of the present invention has been presented for purposes of illustration and description, but is not limited to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. The embodiment was chosen and described in order to best explain the principles of the invention the practical application and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated. For example, the emulation function provided by the present invention may be employed without depending on the time out value of the timer to provide increased response 25 speed or to handle devices, which normally take a long time to respond in the selection phase. While the invention has been particularly shown and described with reference to a preferred

embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

CLAIMS:

What is claimed is:

1. A method in a data processing system for mimicking a device for use within the data processing system, wherein the device may be connected to a bus, the method comprising:
 - 5 detecting a signal on the bus indicating a request to access the device;
 - monitoring the bus for a response by the device; and
 - sending a response to the signal when a selected period of time passes without a response being made by the device.
- 10 2. The method of claim 1, wherein the bus is a small computer system interface bus.
3. The method of claim 1, wherein the step of sending a response includes sending a first signal that indicates a presence of the device being mimicked on the bus.
- 15 4. The method of claim 3, wherein the first signal is a busy signal.
5. The method of claim 3, wherein the step of sending a response further includes sending a second signal to response to the request.
- 20 6. The method of claim 5, wherein the second signal is a not ready signal.
7. The method of claim 5, wherein the second signal is a pre-selected data sequence.
8. The method of claim 1 further comprising:
 - 25 detecting a signal on the bus indicating a request to access a second device;

monitoring the bus for a response by second device; and
sending a response to the signal a selected period of time passes without a response being
made by the second device.

5 9. The method of claim 1, wherein the device is absent from the data processing system.

10. The method of claim 1, wherein the device is connected to the bus and unable to respond
to the request within the selected period of time.

10 11. The method of claim 1, wherein the response is a pre-set response.

12. The method of claim 1, wherein the response is a response acquired by monitoring the
bus for responses made by the device when the device is present on the bus.

15 13. The method of claim 1, wherein the detecting, monitoring, and sending steps are
implemented in a state machine.

14. A method for emulating a device during initialization of an operating system, wherein the
device is configured for use within a data processing system and may be attached to a bus within
20 the data processing system, the method comprising:

monitoring the bus for a signal selecting the device for an input/output transaction during
initialization of the operating system;

monitoring the bus for a response by the device in response to detecting the signal
selecting the device; and

25 sending a response to the signal a selected period of time passes without a response being
made by the device, wherein the response indicates to the operating system that the device is

present within the data processing system.

15. The method of claim 14, wherein the bus is a small computer system interface bus.

5 16. The method of claim 14, wherein the step of sending a response includes sending a signal that indicates a presence of the device being emulated on the bus.

17. The method of claim 16, wherein the first signal is a busy signal.

10 18. A data processing system comprising:
a bus;
detection means for detecting a signal on the bus indicating a request to access the a
device;
monitoring means for monitoring the bus for a response by the device; and
15 transmission means for sending a response to the signal a selected period of time passes
without a response being made by the device.

19. The data processing system of claim 18, wherein the bus is a small computer system
interface bus.

20. The data processing system of claim 18, wherein transmission means includes means for
sending a first signal that indicates a presence of the device.

21. The data processing system of claim 20, wherein the first signal is a busy signal.

25 22. The data processing system of claim 20, wherein the transmission means further includes

means for sending a second signal to respond to the request.

23. The data processing system of claim 22, wherein the second signal is a not ready signal.

5 24. The data processing system of claim 22, wherein the second signal is a preselected data sequence.

10 25. The data processing system of claim 18, wherein the device is absent from the data processing system.

26. The data processing system of claim 18, wherein the device is unable to respond to the request.

15 27. A data processing system comprising:

a bus;

a plurality of devices connected to the bus; and

20 a mimic device connected to the bus, wherein the mimic device monitors the bus for a signal selecting a selected device within the plurality of devices for an input/output transaction during initialization of an operating system within the data processing system, monitors the bus for a response by the selected device in response to detecting the signal selecting the device, and sends a response to the signal a selected period of time passes without a response being made by the selected device, wherein the response indicates to the operating system that the selected device present within the data processing system.

25 28. The method of claim 27, wherein the bus is a small computer system interface bus.

29. The method of claim 28, wherein the signal is a busy signal.

30. A data processing system comprising:
a bus;
5 a plurality of devices attached to the bus; and
a mimic device attached to the bus, wherein the mimic device has a plurality of modes of operation including:
a first mode of operation in which the mimic device monitors the bus for a request to a selected device within the plurality of devices;
10 a second mode of operation, responsive to detecting the request, in which the mimic device monitors the bus for a response from the selected device; and
a third mode of operation, responsive to an absence of a response from the selected device within a period of time, in which the mimic device sends a response to the request onto the bus.

15 31. The data processing system of claim 30, wherein the response includes sending a busy signal onto the bus.

32. The data processing system of claim 30, wherein the response includes sending a not ready signal onto the bus.

20 33. The data processing system of claim 31, wherein the response includes sending a second signal onto the bus.

25 34. The data processing system of claim 30, wherein the bus is a small computer system interface bus.

35. A computer program product for use with a data processing system for mimicking a device, a computer program product comprising:

 a computer usable medium;

 first instructions for detecting a signal on the bus indicating a request to access a device;

5 second instructions for monitoring the bus for a response by the device; and

 third instructions for sending a response to the signal a selected period of time passes without a response being made by the device, wherein the instructions are embodied within the computer usable medium.

10 36. The computer program product of claim 35, wherein third instructions includes instructions for sending a first signal that indicates a presence of the device.

37. The computer program product of claim 36 wherein the first signal is a busy signal.

15 38. The computer program product of claim 36, wherein third instructions further includes instructions for sending a second signal in response to the request.

39. The computer program product of claim 38, wherein the second signal is a not ready signal.

20

40. The computer program products of claim 38, wherein the second signal is a preselected data sequence.

ABSTRACT OF THE DISCLOSURE

A method and apparatus in a data processing system for mimicking a device attached to a bus. Signaling is detected on the bus indicating a request to access the device. The bus is then monitored for a response by the device. If a selected period of time passes without a response being made by the device, a response suitable to indicate the presence of the device is sent onto the bus.

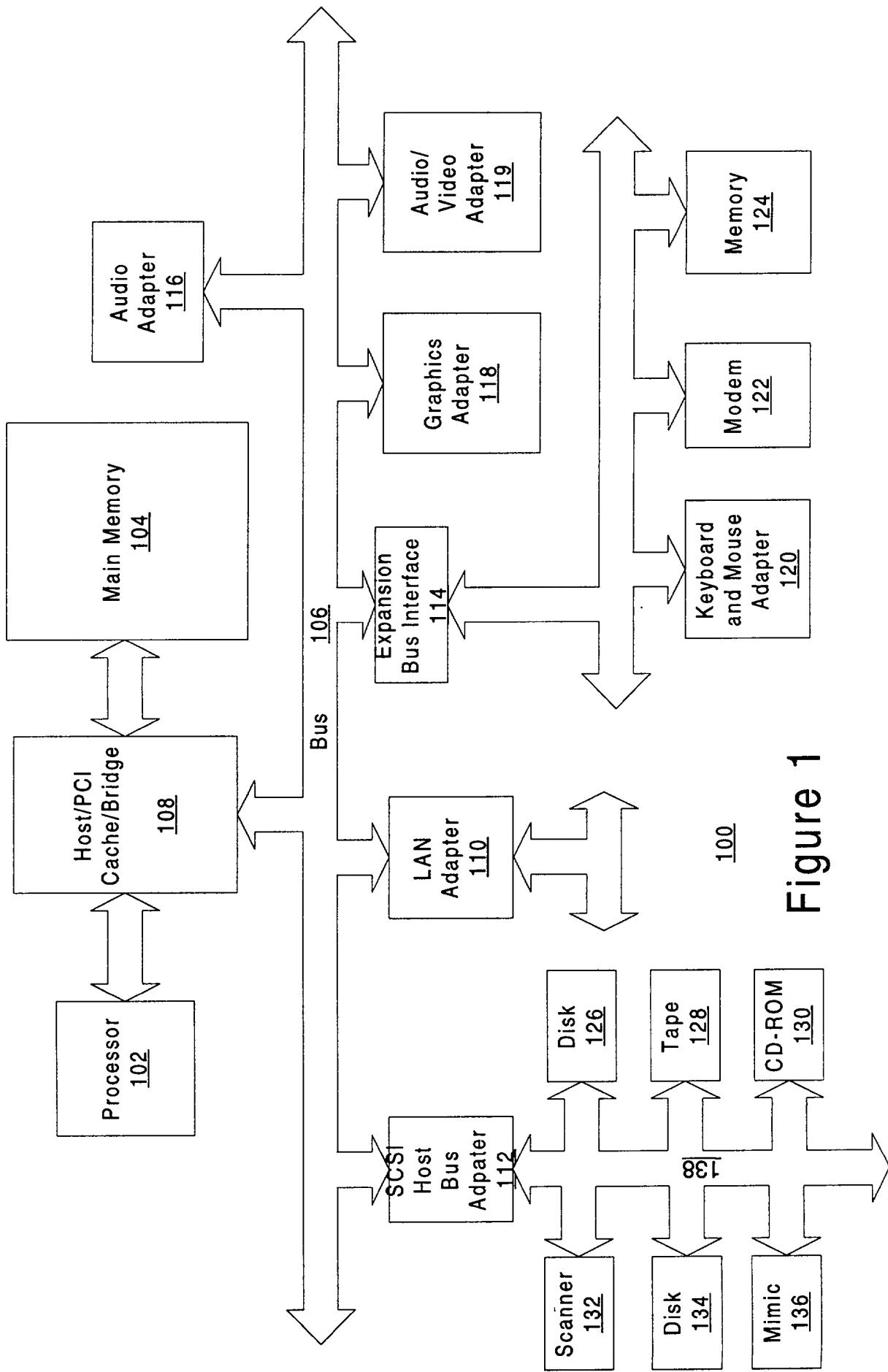


Figure 1

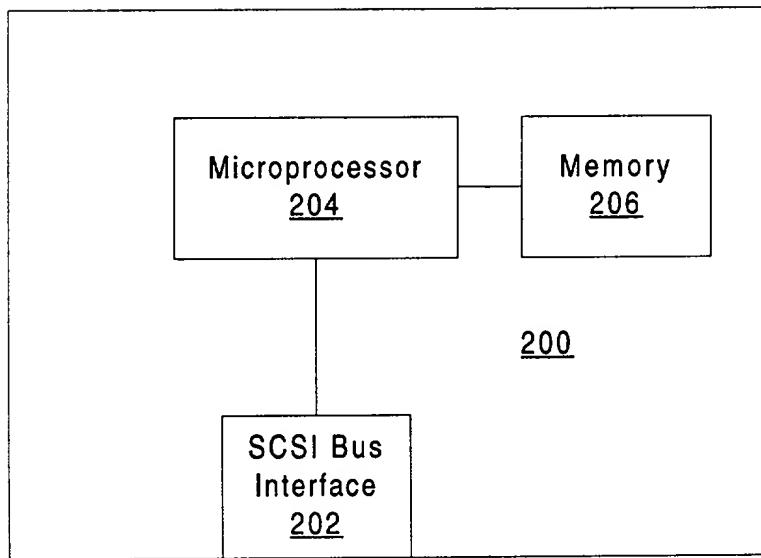


Figure 2

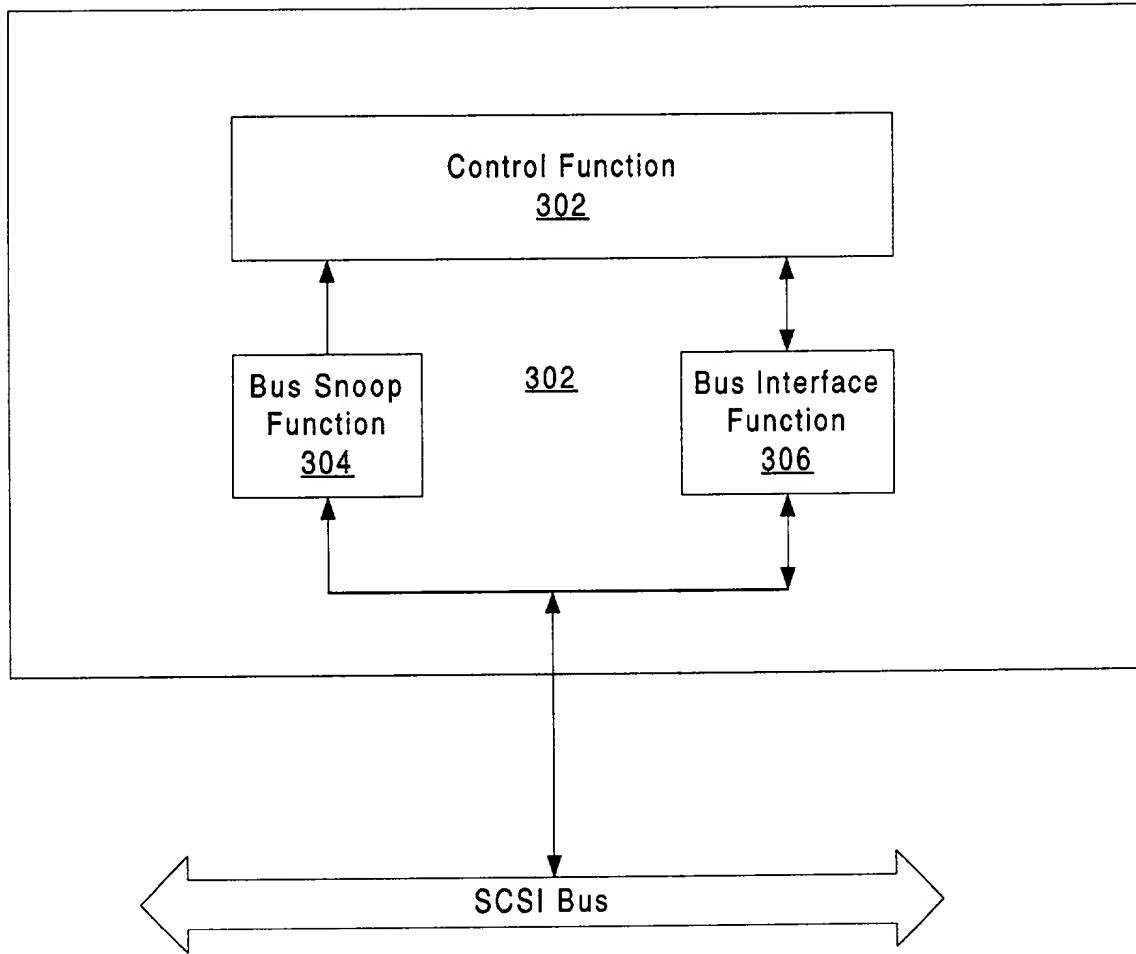


Figure 3

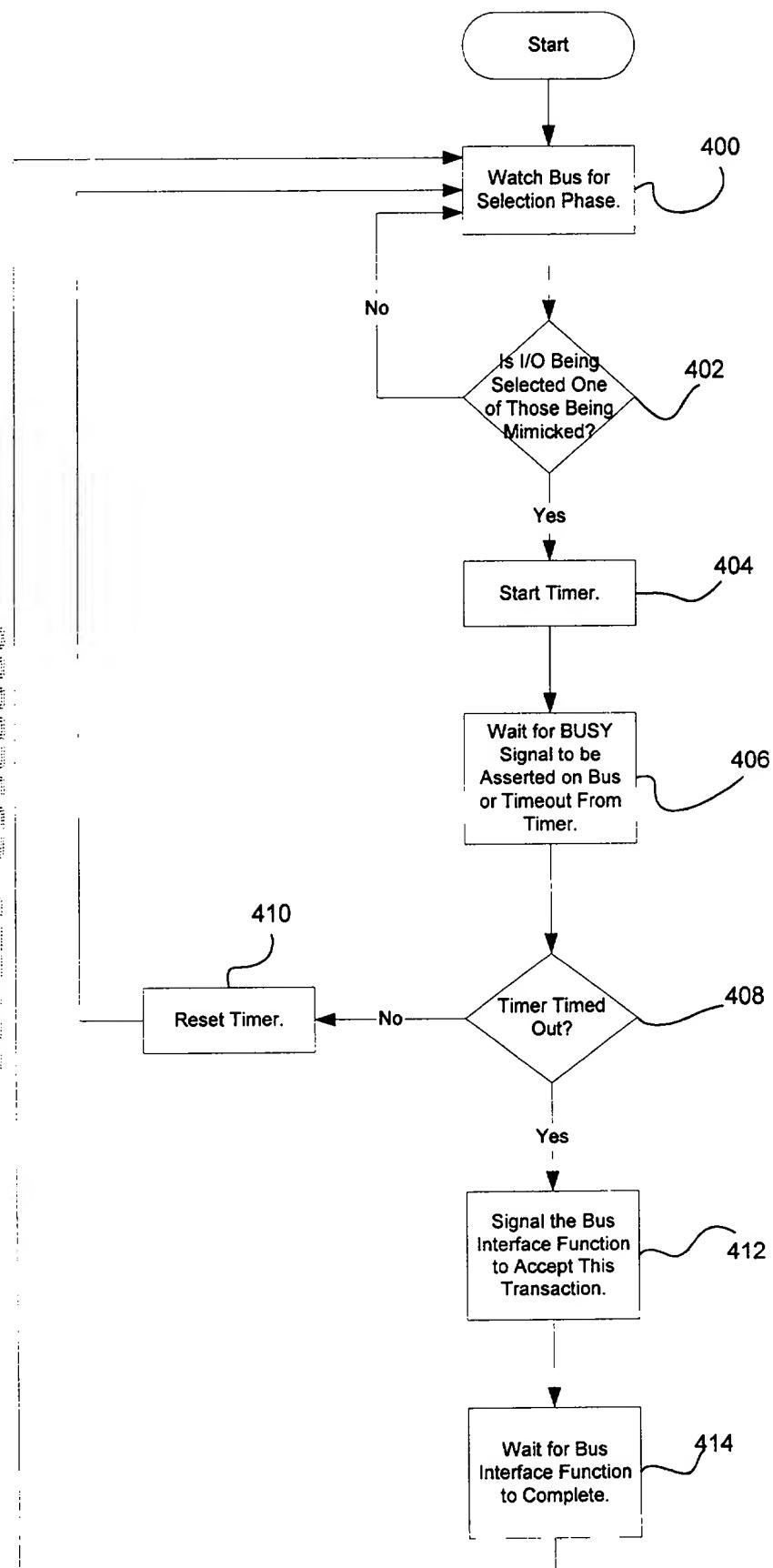


Figure 4

Figure 5

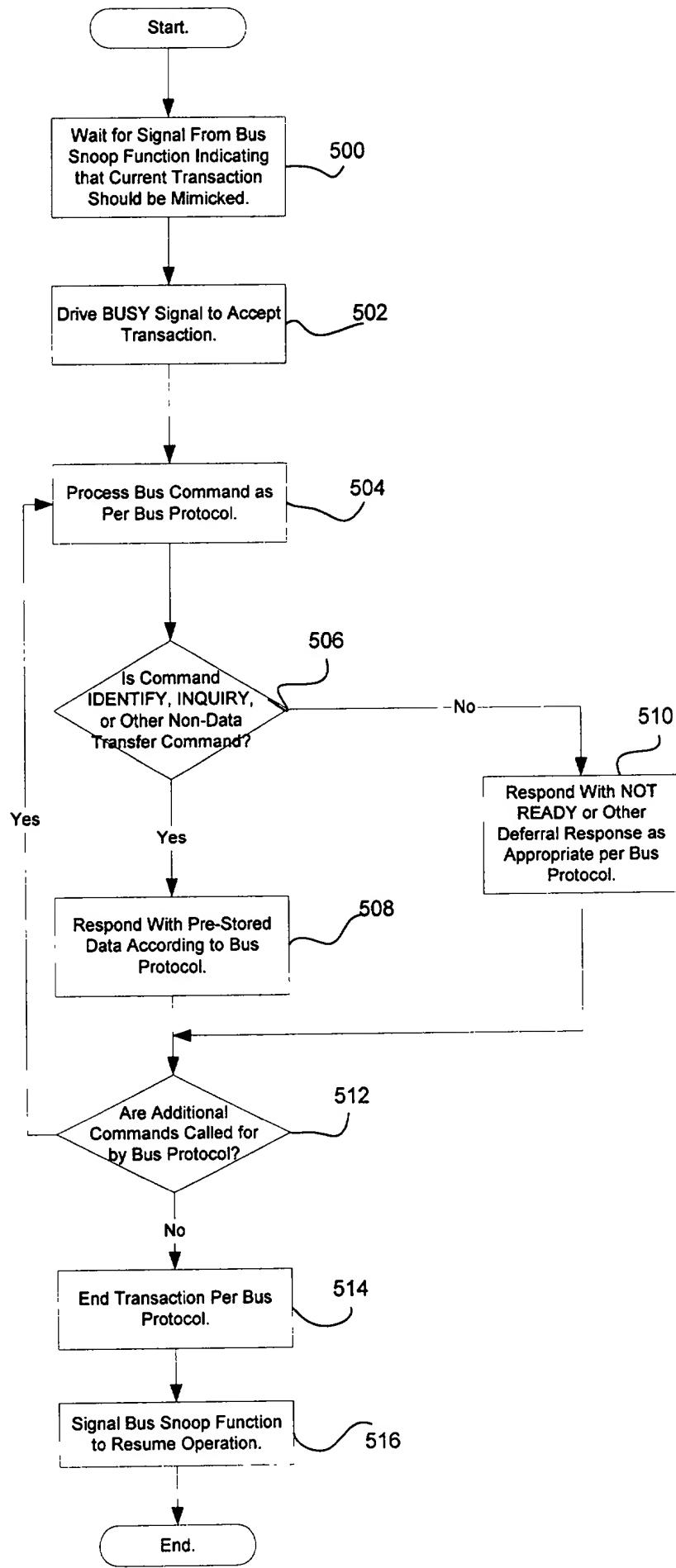
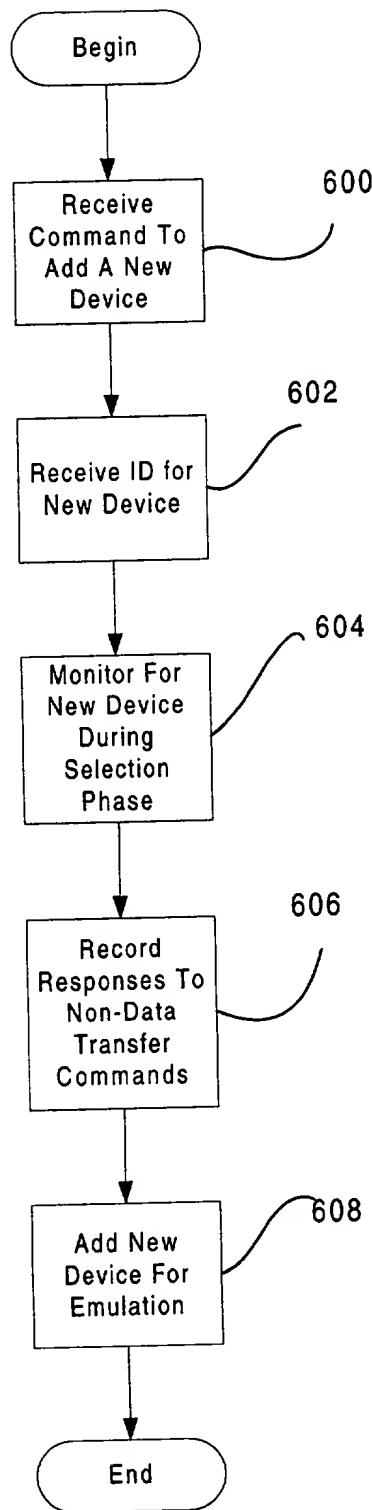


Figure 6



DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

my residence, post office address and citizenship are as stated below next to my name;

I verily believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR EMULATING A DEVICE WITHIN A DATA PROCESSING SYSTEM (Docket No. 97-125), the specification of which

X is attached hereto.

— was filed on _____ as
Application Serial No. _____
and was amended on _____.
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed: **None**

Prior Foreign Application(s) Priority Claimed

(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
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I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application: **None**

(Application Serial No.) (Filing Date) (Status) (Patented, Pending, Abandoned)

And I hereby appoint:

Wayne P. Bailey of Fort Collins, Colorado, Registration No. 34,289
David K. Lucente of Fort Collins, Colorado, Registration No. 36,202

as my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith. I hereby expressly waive my right to revoke the Power of Attorney granted above. Address all telephone calls to Wayne P. Bailey at telephone number (970) 225-4908. Address all correspondence to Wayne P. Bailey, Law Department, Symbios, Inc., 2001 Danfield Court, Fort Collins, Colorado 80525.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole inventor Richard L. Solomon

Inventor's signature Richard L. Solomon Date: 5/18/98

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